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OF THE

Elisha Mitchell Scientific Society

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Society
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JOURNAL
OF THE
Elisha Mitchell Scientific Society

Volume XXXIII NOVEMBER, 1917 Number 3

PROCEEDINGS OF THE SIXTEENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE, HELD AT THE UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL, APRIL 27 AND 28, 1917.

At 2:30 p. m. on Friday, the Executive Committee—President F. P. Venable, Vice-President H. C. Beardslee, and Secretary-Treasurer E. W. Gudger, *ex officio;* J. E. Smith, E. O. Randolph, and Bert Cunningham—met in the lecture room of the Biological Laboratory to review the internal affairs of the Academy. The Secretary-Treasurer reported that the finances of the Academy are in fine condition; that the membership on January 1, 1915, was 72, and on January 1, 1916, 88.

An invitation to hold the 1918 meeting of the Academy at the State Normal College, Greensboro, was unanimously accepted.

The following applicants for membership were elected, after which the Committee adjourned:

Beard, J. G. Associate Professor of Pharmacology, University of North Carolina, Chapel Hill.

Bonney, Miss Emma C. Instructor in Biology, Peace Institute, Raleigh.

Bottum, Miss Frances R. Instructor in Science, Saint Mary's School, Raleigh.

Dixon, L. F. Professor of Science, Weaver College, Weaverville.

Dobbins, C. N. Assistant in Geology, University of North Carolina, Chapel Hill.

Harley, G. W. Instructor in Science, High School, New Bern.

Hewlett, Dr. C. W. Professor of Physics, State Normal College, Greensboro.

MARION, S. J. Instructor in Science, High School, Raleigh.

SEYMOUR, Miss MARY F. Instructor in Biology, State Normal College, Greensboro.

UNDERHILL, G. W. Instructor in Zoology, State College of Agriculture and Engineering, West Raleigh.

At 3 p. m. President Venable called the Academy to order in regular session, and appointed the following committees: Nominating, J. J. Wolfe, J. F. Lanneau, and W. C. Coker; Auditing, Bert Cunningham and E. O. Randolph; Resolutions, George W. Lay, F. E. Carruth and Miss Margaret Wilson.

The reading of papers was then begun with some twenty-five members and a number of visitors present. Adjournment was had at 5:30, when nine papers had been called for and seven read.

At 8 p. m. the Academy reconvened in the lecture room of Chemistry Hall, where it was welcomed to the University by Dean Andrew H. Patterson.

President F. P. Venable of the Academy then gave his presidential address on the subject "The Structure of the Atom." He was followed by Professor Collier Cobb on "Typical Early Maps of North Carolina," with lantern-slide illustrations of many of the maps referred to. The Academy then adjourned to the hospitable home of Professor W. C. Coker, where a highly enjoyable smoker was had.

The Academy at 9:15 on Saturday morning met in annual business meeting. The minutes of the last meeting were read and approved. The Secretary-Treasurer reported that on January 1, 1915, there were 72 members on the roll, that 7 were lost by resignation, removal from the State and nonpayment of dues, and that 23 new members were elected, leaving the membership on January 1, 1916, at 88. The Treasurer-Secretary then read his financial report as follows, calling attention to the fact that our savings bank account was increased last year by $18, due to the fees received from the 23 new members admitted last year. The Auditing Committee then reported that the itemized statement presented by the Treasurer was correct.

Report of E. W. Gudger, Treasurer, 1916-1917

RECEIPTS

Balance last audit	$166.78
Dues since last audit	103.00
Interest savings bank account	4.99
Total receipts	$274.77
Less expenses	94.91
Balance	$179.86

RESOURCES

Savings bank balance	$131.32
Checking bank balance	48.54
Total	$179.86
Dues unpaid (about)	27.00
Stamped envelopes (about)	6.00
Estimated resources	$212.86
Estimated debts	87.75
Estimated balance	$125.11

EXPENDITURES

Proceedings, 1916	$75.00
Stationery	2.20
Printing	4.75
Postage	2.56
Secretary's dues, 1916	1.00
Secretary's expense, Raleigh.	4.05
Secretary's expense, Durham.	2.70
Secretary's expense, office	2.65
Total expenses	$94.91

OUTSTANDING DEBTS

Proceedings, 1916	$75.00
Printing	4.75
Miscellaneous (about)	6.00
Total (about)	$85.75

The Secretary next reported his visit to the meeting of the Southern Association of Colleges and Secondary Schools at Trinity College, and his appearance before its Committee on Curriculum. Membership could not be had in the Association by the Academy, but, thanks to the courtesy of Professor E. C. Brooks of Trinity College, a member of the committee noted above, it was possible for the Secretary, together with Messrs. J. J. Wolfe and Bert Cunningham, to meet with the committee and discuss the question of science teaching in the high school. The committee discussed mainly and was very much divided on the question of general science versus the special sciences. The Secretary opposed the teaching of general science and proposed for high schools in the country and in small towns the biological and physiographical sciences, and argued for physics and chemistry only in larger towns and cities. Domestic Science and Agriculture were favored when based on adequate preparation in Biology and Chemistry. The committee of the Association was re-

ported as in earnest about the matter, but doubtful as to what was best. Their decision was announced as deferred till the 1918 meeting of the Association.

Considerable discussion followed this report, and on motion the Secretary was appointed to attend the 1918 meeting of the Association and press upon the committee the advisability of establishing in the high schools the separate sciences as indicated above. His expenses are to be paid by the Academy.

Later in the session, immediately after the reading of the illuminating report by Professor Marion on science teaching in the high schools of the State, considerable discussion was again had, and the following motion by Professor Cunningham was carried:

"That a committee of three from the colleges, one from each department, Biology, Physics, Chemistry, be appointed to coöperate with a similar committee from the Science section of the State Teachers' Assembly, in studying the subject of High School Science, with reference to its increased efficiency."

The committee as appointed consists of J. J. Wolfe, Andrew H. Patterson, and S. J. Marion.

The suggestion met with general approval that an effort be made in 1918 to increase our membership among the high school teachers of sciences and mathematics, and that, if members justify it, the purpose be kept in mind of forming a section in the Academy for them.

A motion was next made and carried to print the name of the Executive Committee on the program, that they might be reminded of their duties.

The Secretary then asked that members notify Professor Coker, editor of the MITCHELL JOURNAL, of changes of address and of failures to receive the JOURNAL.

The Secretary next read a letter from Mrs. Joseph A. Holmes, expressing her appreciation of the resolution adopted by the Academy one year ago on the life and services of Professor Holmes.

Professor Cobb next reported that action was being taken by Congress in the matter of mapping of our Atlantic Coastal Plain with reference to possible war conditions and needs.

The Nominating Committee then reported, and the following officers were elected for 1917-18:

President—W. A. Withers, Professor of Chemistry, State College of Agriculture and Engineering, West Raleigh.

Vice-President—J. H. Pratt, State Geologist, Chapel Hill.

Secretary-Treasurer—E. W. Gudger, Professor of Biology, State Normal College, Greensboro.

Additional members of Executive Committee:

Bert Cunningham, High School, Durham.

H. R. Totten, University of North Carolina, Chapel Hill.

H. C. Beardslee, Asheville School, Asheville.

The Committee on Resolutions next reported as follows:

Resolved, That we, the members of the North Carolina Academy of Science, hereby return our most cordial and appreciative thanks to the University of North Carolina and its President and Faculty for their hospitality and for the arrangement for our meetings which have been both pleasant and convenient; and also we thank our kind hosts and hostesses for their boundless and gracious hospitality. Especial thanks are expressed to Professor Coker for his entertainment of the Academy on Friday evening, and to the University for the delightful lunch in Swain Hall on Saturday.

At 9:50, Vice-President Beardslee in the chair, the reading of papers was begun in the joint meeting of the Academy and the North Carolina Section of the American Chemical Society. The chemical papers in the Academy and those of general interest on the Chemists' program were read.

The Chemists then withdrew and the Academy resumed its regular order of business until 1:40 p. m., when all the twenty papers remaining on the program had been read. Adjournment was then made to Swain Hall, where the scientists were entertained at luncheon by the University.

The membership of the Academy at the present time is as follows, those present at this meeting being indicated by a *:

Allen, W. M.
Andrews, Theodore
Balcomb, Prof. E. E.
Balderston, Prof. Mark
*Beard, Prof. J. G.
*Beardslee, Prof. H. C.
*Bell, Prof. J. M.
Bonney, Miss Emma C.
*Bottum, Miss Frances R.
Brewer, President Chas. E.

Brimley, Mr. C. S.
*Brimley, Mr. H. H.
Bruner, Mr. E. Murray
Bruner, Mr. S. C.
Cain, Prof. William
*Carruth, Mr. F. E.
Clapp, Mr. S. C.
*Cobb, Prof. Collier
Cobb, Mr. William B.
*Coker, Prof. W. C.
Collett, Mr. R. W.
*Cunningham, Prof. Bert
*Detjen, Mr. L. R.
Dixon, Prof. L. F.
*Dobbins, Mr. C. N.
Downing, Prof. J. S.
*Edwards, Prof. C. W.
Farmer, Prof. C. N.
Field, Mr. R. H.
*Gudger, Prof. E. W.
Hammel, Prof. W. C. A.
*Harley, Prof. G. W.
*Henderson, Prof. Archibald
Hewlett, Prof. C. W.
Hobbs, Mr. A. W.
Hoffman, Dr. S. W.
*Holmes, Mr. J. S.
*Johnson, Prof. E. D.
Kilgore, Prof. B. W.
Lake, Prof. J. L.
*Lanneau, Prof. J. F.
*Lay, Rev. George W.
*Leiby, Mr. R. W.
Lewis, Dr. R. H.
Lyon, Prof. Mary
McIver, Mrs. Charles D.
*Marion, Prof. S. J.
Mendenhall, Prof. Gertrude W.
Metcalf, Prof. Z. P.
Newman, Prof. C. L.
Nowell, Prof. J. W.
*Patterson, Prof. A. H.
Pegram, Prof. W. H.
Pillsbury, Prof. J. P.
Poteat, President W. L.
Pratt, Dr. J. H.
*Randolph, Prof. E. O.
Randolph, Mrs. E. O.
*Randolph, Prof. E. E.
Rankin, Dr. W. S.
Riddick, President W. C.
Roberts, Dr. G. A.
Robinson, Miss Mary
Seymour, Miss Mary F.
Sherman, Mr. F., Jr.
*Shore, Dr. C. A.
*Smith, Mr. J. E.
*Spencer, Mr. H.
Strong, Prof. Cora
*Totten, Mr. H. R.
*Underhill, Mr. G. W.
*Venable, Prof. F. P.
*Ware, Mr. J. O.
*Wheeler, Prof. A. S.
*Williams, Prof. L. F.
*Wilson, Prof. H. V.
*Wilson, Miss Margaret
Wilson, Prof. R. N.
Withers, Prof. W. A.
Winters, Prof. R. Y.
*Wolf, Prof. F. A.
*Wolfe, Prof. J. J.

In addition to the presidential address, which is published in full in the current number of the JOURNAL OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY, the following papers were read:

Pliocene Deposits in Orange County. JOHN E. SMITH.

These occur on the divides and on the higher terraces in the plateau section of the county and generally over the Triassic area except on the floodplains and on the steeper slopes near the streams.

On the upland (elevation, 500-600 feet) this material consists of smooth, rounded pebbles and cobbles (some of which are polished) of quartz and quartzose minerals up to 6 inches or more in diameter, together with fragments of the same and of other minerals down to the size of soil particles. In the Triassic area (elevation, 250-400 feet) the deposit comprises gravel, sand, and soil (in addition to the above), in some places reaching a thickness of a foot or more. This material has been transported from a distance and characterizes the Granville soils, distinguishing them from those of the Penn series, which are derived from the Triassic rocks in place.

The thinly distributed pebbles on the higher divides of the county may be remnants of river deposits on a peneplain, but the soils, etc., of the lower interstream areas are doubtless of Lafayette age. (Illustrated with lantern slides.)

Saprolegnia anisospora in America. W. C. COKER.

This species has not before been reported in America. We have found it twice in Chapel Hill, in marshy, shaded places containing algæ. It is distinguished chiefly by the following characters:

1. The presence of spores of two or three sizes, borne usually in separate sporangia without regard to the size of the latter; the small spores from 10.5-11μ in diameter, the large ones from 13.7-14.8μ in diameter. In nearly all cultures there are formed a few very large spores, at least twice the size of the ordinary large ones, these appearing mixed in with the latter.

2. The irregular shape of the sporangia, which are not evenly cylindrical, but more or less waved, bent and constricted, and which proliferate either laterally from below, as in Achlya, or within the old ones, as is usual in Saprolegnia.

3. In sexual reproduction numerous oogonia are formed, each with one or more antheridia of diclinous origin.

The Jaws of the Great Barracuda, Sphyraena barracuda. E. W. GUDGER.

A careful description illustrated by photographs, and a specimen was given of the teeth and jaws of this fish. Their use was briefly described and some accounts of the ferocity of the fish narrated. In

the waters of southern Florida it is generally more feared than the shark, being bold and inquisitive where the shark is cowardly. The data presented is part of a paper in press in a volume of memoirs from the Tortugas Laboratory of the Carnegie Institution at Washington.

The Status of the Science Work in the High Schools of North Carolina. S. J. MARION.

This survey and report will be published in full in the forthcoming issue of the *North Carolina High School Bulletin.*

Armillaria mellea, Clitocybe cespitosa, Pleurotus sapidus, and Claudopus nidulans in Pure Culture. H. R. TOTTEN.

Mycelia of the four mushrooms were shown in pure culture on several media, also drawings of the mycelial threads as seen under high power. *Armillaria mellea* forms a slow growing, closely flocculent, cream-colored mat, and soon produces long brown to black root-like rhizomorphs. In agar these rhizomorphs are beautifully shown radiating from the mat-like central mass. The mycelium of *Clitocybe cespitosa* is much like that of *Armillaria mellea,* but the threads are not so closely woven and the rhizomorphs, or root-like bodies, are white. It is shown that *Armillaria mellea* and *Clitocybe cespitosa,* while very closely related, are not the same. The mycelium of *Claudopus nidulans* is silkier and is from white to pink in color. The mycelium of *Pleurotus sapidus,* except in old cultures, is loose and silky and is very fast growing, soon covering the medium with a mass of pure white threads. Fruiting bodies of both *Pleurotus sapidus* and *Claudopus nidulans* were shown developing in pure cultures.

Structural Geology of Orange County, N. C. JOHN E. SMITH.

With few exceptions the rocks of this county occur in long, narrow belts and "islands" extending north 65° east. Named in their order from the southeast these areas comprise the Triassic sedimentaries, granite, diorite, rhyolite, schists and greenstone, diorite, schists and phyllite, greenstone and schists, diorite, schists and greenstone, diorite, granite.

The structure of these rocks is that of a syncline, whose trough centers along the line of strike and passes near Cheek's Siding about three miles east of Mebane. Measured along the dip, this syncline is approximately twenty miles wide and probably contains folds of minor importance within it. The major joints, flow lines, etc., of the igneous rocks in many places parallel both the dip and the strike of the schists belts. Inclusions of the diorite in the granite attest the greater age of the former, and the presence of belts of igneous rocks beneath the margins of the syncline certify their contribution to the structure and prove the greater age of the schists, etc. South of Chapel Hill beyond Morgan Creek the strike is due east and west and the conglomerates, slates, and rhyolites dip to the south at an angle of 65°. (Illustrated with maps, charts, and structure sections.)

State Regulation of the Sale and Manufacture of Gas. C. W. EDWARDS.

In 1910, out of 228 cities in the United States of more than 25,000 population, only 47 had no requirements such as are in a bill proposed for North Carolina. Of these 228 cities, 103 are under State laws and have no additional municipal regulations. A number of cities, such as Baltimore, Buffalo, Los Angeles and Milwaukee, have local provisions in addition to State laws. In 1910, sixteen States had laws providing for the State inspection of meters and of the purity of gas—Connecticut, Georgia, Kansas, Maryland, Massachusetts, Nevada, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Vermont, Virginia, Washington, Wisconsin, and California. (B. of S. Circular No. 32.) Doubtless the list is now larger.

In 1910 the net income to the State of Massachusetts from meter testing alone was over $5,000. The total cost of the tests on quality, purity, pressure, etc., was assessed on the operating companies according to their sales. Meter testing is on the fee basis. There is no good reason why such a department in North Carolina would not yield a revenue to the State.

That the Corporation Commission in North Carolina should have the power and machinery at its command to protect the interests of citizens seems obvious for the following reasons: Under existing

law it is the duty of the Commission to regulate the rates to be charged by gas companies. The proper price is determined in a large measure by the quality of product sold, and this is almost at the will of the producer. Gas in New York City furnishes 680 heat units per cubic foot and is sold at 80 cents. Gas in Durham furnishes at times less than 500 heat units and is sold at $1.50. In one city in this State gas furnishing 412 heat units sold for $1.60. The standard requirement in regulated States is around 600 heat units. The difference in quality means a loss of from five to twenty thousand dollars per year to consumers in various towns of this State, and the loss would easily run into hundreds of thousands to the State at large. While it may be to the interest of certain communities to sell a cheap, poor gas, it is safe to say that it is always against public interest to have a cheap, poor gas sold at a rich, high price. To fairly meet its responsibility the Commission must know from its own tests the quality of the product sold. The consumer is entirely helpless.

Aside from the question of rates, the public is vitally interested from the standpoint of health. In the method of manufacture used by one company in this State, carbon monoxide and hydrogen are produced in equal quantities. Both of these gases are odorless and one is a deadly poison. Combined they give a cheap gas furnishing about 300 heat units. This gas causes a meter to register just as fast as a 600 heat unit gas. It is the duty of this company to carburet this gas with an oil which not only brings its heat value to standard, but gives it a very pungent odor that makes it noticeable in case of a leak. In this town a series of fatal accidents have occurred, due solely to the neglect of the service company. In other methods other deleterious elements are introduced by carelessness, so that in all cases, public interest demands systematic testing under the authority of the State.

It is just as reasonable to let manufacturers sell anything called fertilizer without tests as to composition as it is to permit of the sale of untested gas. Our duty to test meters is just as obvious as our duty to test weights and measures.

The advantages resulting from such an act would not even be principally with the citizen. An expert employed by the State to travel

from plant to plant, observing and testing, corrects irregularities and errors in manufacture that may mean thousands of dollars saved to the companies. If ammonia appears in the gas it means that a valuable by product is being lost. So it is with other errors of manufacture. The fact that meters are tested by the State brings a feeling of confidence to the consumer that is worth much to the gas companies. Uniform, improved, and economical manufacture brings new and profitable business, and this more than compensates for any costs involved.

The Pollination of the Rotundifolia Grape. L. R. DETJEN.

This paper appears in full in this number.

No abstracts have been received for the following papers:

The Relative Toxicity of Uranium Nitrate in Animals of Different Ages. WM. DEB. MACNIDER.

Trembles. FREDERICK A. WOLF.

Permanency in Fleshy Fungi. H. C. BEARDSLEE.

Sound Wave Photography (Lantern). ANDREW H. PATTERSON.

Evolution in Sponges and Changes in Classification. H. V. WILSON.

The Revision of the Atomic Weight of Zirconium. F. P. VENABLE and J. M. BELL.

Recent Investigations About Cotton-seed Meal. W. A. WITHERS and F. E. CARRUTH.

The Physics of the Shrapnel Shell. ANDREW H. PATTERSON.

Portolan Charts (Lantern). COLLIER COBB.

The Idea of Force in Mechanics. ANDREW H. PATTERSON.

The Times We Think In. GEORGE W. LAY.

The Life History of the Pecan Trunk Borer. R. W. LEIBY.

E. W. GUDGER, *Secretary.*

SOME NOTES ON THE OCCURRENCE OF LANDSLIDES

By J. S. Holmes

The serious landslides which occurred during the unprecedented floods in Western North Carolina in July, 1916, were confined largely to the area of heaviest rainfall on the southeast slope of the Blue Ridge. In the region where the first storm was the heaviest and the second carried comparatively light rainfall—as, for example, in the Highlands region—few, if any, landslides occurred. They were largely confined to the areas where the first storm, carrying from 4-10″ of rain, thoroughly saturated the soil; while the second storm, discharging from 10-23″ of rain and coming before the water of the first had time to drain off, caused a heavy supersaturation of the soil.

Damage—The damage from slides occurred in various ways. The first injury probably resulted in the carrying down into the excessively swollen streams trees and loose timbers which were washed down for many miles, sometimes lodging in or against trees, so that the river banks were washed out; at other times forming drifts against bridges which caused them to wash away. It is difficult to determine what was the actual added damage these slides caused in this way, but it must have been enormous.

Many of the local residents suffered directly from these slides: houses were struck and demolished; barns, sawmills, etc., destroyed or greatly injured; gardens and fields covered up or torn out; and crops on restricted areas ruined. No loss of life is recorded from these slides, but many narrow escapes were related.

In some places roads were injured by slides almost as much as by the high water. Railroads were perhaps even more injured in this way. Sometimes a slide occurred just above the road, possibly caused by undermining the surface of this ground; occasionally slides from above continued on past the road, carrying the road with them; often roads and especially railroads slided from the road down. Such places are exceedingly hard to repair, as there is little or no foundation for the road without digging still farther into the bank. Such repairs make excessively bad curves.

The permanent damage to the land has been comparatively small from this cause. Slides rarely exceed an acre in extent, though some have laid bare as much as four or five acres. The subsoil opened up will, in due course of time, become clothed with vegetation, but for a long time to come it will be practically barren and worthless. On the other hand, where slides have run over areas of more level land, though in many cases rich bottom-land has been covered from 1 to 3 feet deep with a subsoil of thoroughly decomposed rock, these areas can be cultivated and in a few years with proper management will probably yield fair crops.

A minor injury caused by slides is an opening up of the soil on city watersheds, allowing the ordinary rains to carry into the streams silt and mud, where previously the forest cover had prevented this. A number of such slides occurred on the Marion watershed, and the town will undoubtedly experience some trouble from this cause for some time to come. The Asheville watershed has suffered less from slides, so that probably no appreciable results will be seen.

Occurrence.—Although, so far as I am aware, no previous occurrence of slides in this region has been recorded, many of the residents of the region mentioned having seen slides at some previous time. George Bird at Marion said that during the May freshet of 1901 many slides occurred. On a branch near his house the slides brought down lots of timber. There were also cracks in the mountain-sides where the slides did not actually occur. He mentioned the fact that no subsequent rain has been sufficient to carry these still farther. Other people said that twenty-five years ago some slides occurred, though none of them remembered nearly as many as this year.

Practically all the slides occurred between about 5 o'clock Saturday evening, July 15, and 7 o'clock the following morning. The first ones were seen before dark Saturday evening, and some were seen after daylight on Sunday; they were heard at all times through that night. This was the time of heaviest rain and highest flood water. The rain slacked up about 7 o'clock in the morning, and was practically over for the day at 10 o'clock.

Many of the mountain people have their own ideas of what caused the slides. Some, even of the better informed, attributed them to

"waterspouts," namely, high columns of water coming down and striking the earth, tearing holes in the mountains where the "waterspouts" struck. Others attributed them to "cloudbursts," by which they mean nearly the same thing, though they have not as definite an idea of what a "cloudburst" is. One man at Clear Creek, in McDowell County, thought they were caused by volcanic action. He said that, undoubtedly, had it been light, a blue smoke would have been seen issuing from the rent in the earth. As corroborative evidence, he said that the earth coming from the slide had settled so hard that it was impossible to get the point of a plow into it; he had already tried. Many spoke of the night being quite light; in spite of the dense clouds and rain, a kind of white color prevailed. If so, this probably was caused by the moon, which was then nearly full.

From an economic standpoint, the study of these slides is comparatively unimportant. Only a small percentage of the mountain country was affected by them, and, even where they were worst, an insignificant percentage of the area was affected. The damage done by the slides, both directly and indirectly, would be in the aggregate considerable; but, from previous experience, there is little prospect of another such visitation in the near future. From a scientific point of view, however, they are most interesting.

Causes.—Contrary to the view of many casual observers, these landslides were in no case the result of erosion. They were caused by water *in* the soil and not *on* it. Signs of erosion were often evident in landslides, but the channels cut through the homogeneous mass of deposited soil showed conclusively that the slide occurred all at once, and what erosion there was took place subsequently.

It is very difficult, especially for such a one as myself who is not a geologist, to arrive at any definite conclusion as to the immediate cause of the slides. Undoubtedly the supersaturation of the soil with rain was the controlling cause; but this does not explain why the slides occurred in some places and not in others. Most of the larger slides occurred in slight hollows where the soil was deep and where the largest amount of water would be collected in the soil. Most of the slides from such situations came down as liquid mud, which is proved by the way in which it was plastered over the ground along its course

and the way in which it spread out in a fan shape over the level lands below. Numberless instances of such methods of sliding were seen. In such cases the surface soil matted together with tree roots or with turf, as the case might be, held together or was only partly broken up, while the semi-liquid soil below was pushed out by the weight of the surface. Many instances were seen where trees remained standing in place when the whole surface, many yards in extent, had fallen several feet down the slope.

Topography.—Though the larger number of slides occurred where the slopes were exceedingly steep, many were also found on moderate slopes, especially where the ground dropped slightly into a hollow. In fact, very few slides were seen, other than those where streams, roads or railroads had undermined a bank, except in slight hollows which normally carry no surface water. Some of the larger slides have continued from such comparatively small beginnings down branches to the open valley; but in nearly all cases these originated above the head of the surface streams.

Depth of Decomposition.—More slides seem to have occurred on the south, east, and west slopes, and fewer on the north slope. This may in part be due to the fact that in the area of heaviest rainfall there is a larger proportion of such slopes; but undoubtedly it is chiefly due to much greater depth of decomposition of the rocks on the southerly slopes. An average depth of slides was something like five or six feet, though they varied from two to 20 feet deep, and even at such depths very seldom was the solid rock exposed.

Only a small percentage of the slides which were seen carried soil from a sloping rock; that is, left exposed a rock sloping in the direction of the slide. In certain cases the slope of the bedrock seemed to be a determining cause of the slide; but such cases were few.

Nature of Rock and Soil.—Most of the slides occurred in a topsoil composed of thoroughly decomposed rock, sometimes containing large boulders. The amount of mica in the soil or rock seemed to have affected the proportion of slides only slightly. In the upper John's River Valley, for instance, there are a number of slides where the rock is evidently fairly micaceous; yet, lower down the river, there seemed quite as many where the soil is granitic gneiss, or what is

commonly called "calico rock." They most often seem to have occurred on hillsides where the rock was thoroughly decomposed to a depth of from 5 to 20 feet. Wherever the soil had in previous ages filled in the heads of depressions from above and on each side, and where the surface and subsurface water would naturally flow together in such places—even though the slope were not very great—slides might occur. In other cases, however, slides started at the tops of the hills; for example, a small hill close to Globe, where five or six slides actually started on the crest of the hill. Here, however, the slopes were very steep and the rock decomposed to a great depth. In this place there were indications of slides having occurred in previous years, probably many decades, perhaps centuries, ago.

Forest Cover.—The soil cover seems to have made little or no difference in inducing slides: they often extended a short distance above the fields into the woods, and frequently started entirely above the fields. Heavy timber on an area would sometimes seem to save it from sliding and occasionally a slide would be stopped by large trees which probably had roots in the rocks and could not easily be moved. On the other hand, some small slides seem to have been caused by the weight of some tree on earth which was supported on a sloping rock. As there was no wind during the storm, only the sheer weight of the trees, together with the large amount of water, could have had any influence in breaking the soil. The greater number of slides occurred in woodland which had been cut and burnt over; this, however, is probably because the largest percentage of the affected area is in this condition. Professor C. F. Marbut of the United States Bureau of Soils, who visited the area in company with the writer, says:

> **"Given the same soil and slopes, the soil will presumably become more thoroughly saturated in a given short time in a forest covered area than on a cultivated slope where the water would run off rather than soak in."**

From this it would seem that the physical features which enable the forests to retard the run-off, and thus tend to control floods during periods of normal precipitation, might even increase the liability to landslides during periods of such excessive rainfall. Conditions were

so complicated, however, that no conclusive evidence could be secured to show the influence of an ideal forest cover on landslides.

Prevention.—It would seem that there is little that can be done to prevent the recurrence of such a visitation, or even to mitigate the damage. The probability of a similar disaster occurring again in the same place seems so remote that large expenditures of money, time, and material seem hardly justified. Railroads will undoubtedly increase to some extent the size of their culverts and the heights of their bridges, and farmers may shun for a few years the mouths of hollows for new house and barn sites, but certainly no extensive measures can be undertaken. Judging by the past, it may be twenty-five, one hundred, or five hundred years before another such visitation comes to that region. When it does come, the larger the area of steep slopes at the headwaters of streams that is in well managed forests, such as the Federal Government is gathering under its ownership, the better it will be for the people of the region and of the whole State.

CHAPEL HILL, N. C.

SOME NORTH CAROLINA SOIL STATISTICS AND THEIR SIGNIFICANCE

By Roland M. Harper

INTRODUCTION

Ever since soils began to be studied from a chemical standpoint attempts have been made to correlate soil chemistry with natural vegetation,* but most of them have not been very satisfactory, partly because attention has been directed chiefly to the more conspicuous and easily identified minerals, particularly limestone, and partly because the vegetation has not been studied quantitatively. Lists of supposed calciphile and calcifuge plants were prepared long ago, but it was soon found that some species which appeared to be calciphile in one region were calcifuge in another, showing that lime was not the deciding factor. The mere presence or absence of certain species is not very significant anyway, for two areas with quite different soils might conceivably have exactly the same species of plants, but in different proportions, giving the vegetation very different aspects.

Another difficulty about making such correlations is that soil chemists have never agreed as to what method of analysis gives results most consistent with vegetation and crop yields. A complete analysis by the fusion method leaves little room for difference of opinion, but it gives no indication of how much of the total plant food becomes available in a year or in a century. (By that method a block of granite might appear equal to a very fertile soil, in everything except nitrogen.) The method used by the Association of Official Agricultural Chemists is one of the quickest, but does not do justice to the potassium.† Hilgard's acid digestion method seems to be the most significant, but it requires about a week to carry it through, and therefore has never been very popular. Mineralogical analyses are preferred by some,‡ but little progress seems to have been made as yet in correlating such analyses with vegetation and crops.

*For a summary of investigations along this line see Chapters 24 and 25 of Hillgard's Soils, 1906. See also 6th Ann. Rep. Fla. Geol. Surv., 175-177, 396 (footnotes). 1914.

†See Hilgard, Soils 340-343; Science II, 42:527-528. Oct. 15, 1915. Also, 6th Ann. Rep. Fla. Geol. Surv., 397-398. 1914.

‡See G. N. Coffey, U. S. Bur. Soils Bull. 85:86-99. 1912.

Chemical analyses of soils have fallen somewhat into disrepute in recent years, and have been largely superseded by physical or mechanical analyses, which are much more quickly and cheaply made, by passing the dry soils through a series of sieves of increasing fineness, and calculating the percentage retained by each. Although not much has been done yet in the way of correlating soil texture with vegetation, it is evident that other things being equal the finest-grained soils ought to be the most fertile, except that clay (especially if non-calcareous) and muck are often less so than the clay loams and silt loams, on account of imperfect aeration. Some of the relations between soil texture and vegetation will be brought out in the following pages.

Our knowledge of the chemistry of North Carolina soils is unfortunately very limited. There are several analyses in Emmons's reports of 1856 to 1860, but they are not strictly comparable with more modern ones. In Kerr's report on cotton production, in the 6th volume of the Tenth Census, 1884, analyses of soils from several localities, presumably made by Hilgard's method, are given, but there are not enough from any one natural region to be sufficiently representative, and some regions are not represented at all. Bulletin 57 of the United States Bureau of Soils summarizes all the chemical analyses of soils in the United States found in literature in the eighteen years preceding 1909, and there are only two from North Carolina.

Since 1900 the United States Bureau of Soils has published reports on about thirty-five counties or similar areas in North Carolina, distributed over the State in such a way as to give a pretty fair representation of the soils of each congressional district, and incidentally of every natural geographical division. In each of these reports the soils are classified according to color, texture, moisture, etc., and mapped in colors, and the area of each type is given in the text, usually in multiples of 64 acres. With the aid of the soil maps, nearly all of which are on a scale of an inch to the mile, it is a comparatively simple matter for a person familiar with the boundaries of the geographical divisions to estimate the percentage of each type of soil in each region.

To keep each of the hundreds of soil types separate in making a soil census of a whole state would require considerable space; but they

may be grouped either by series or by texture classes (*e. g.*, fine sand, stony loam, silty clay, etc.). Each series is intended to include soils having a similar origin, color, and moisture content, though varying in texture, and the name is usually a geographical one, suggested by the locality where the series was first differentiated. The number of series recognized by the Bureau of Soils has increased enormously since the first few years of soil survey work (the number was 534 on January 1, 1912, and may be nearly 1000 now), so that the later reports contain many more series names than earlier ones on neighboring or similar regions. In Bulletin 96 of the Bureau of Soils (1913) there is a long list of soil names that have been changed since publication (see page 745 for those in North Carolina), but one has no assurance that every desirable change was made there, or that other changes have not been suggested since the publication of that bulletin (which was the last of its series). Indeed in many cases the soil nomenclature cannot be revised properly without reëxamining the areas in question, at considerable expense, and subdividing some of the types as mapped into three or four.

Another difficulty about using the series names for statistical purposes is that the distinctions between different series are now drawn so finely that precisely similar soils in different areas may be referred to different series by different men, or even by the same man at different times. Furthermore, the series names are meaningless to persons not familiar with the publications of the Bureau of Soils, and have no logical sequence, while the texture classes have self-explanatory names, and can easily be arranged in approximate order of fineness.

For these reasons the soil statistics given below are based on texture only; but for each region the principal soil series are indicated. Of course the texture classes are connected by all possible gradations, and are just as liable to be interpreted differently at different times or by different men as are the series; but such errors can never be very large, and they tend to balance each other when several areas are taken together. Perhaps the greatest difficulty is the loose usage of the terms "meadow" and "swamp." At first these names were applied to many different kinds of wet soils, whether they bore meadow or

swamp vegetation or not; but the tendency has been more and more to refer such soils to definite series and texture classes.

As is well known to readers of this journal, North Carolina has two major divisions of approximately equal size: the up-country, or region of hills and hard (mostly crystalline) rocks and residual soils, and the low country or coastal plain, with sedimentary and mostly unconsolidated rocks. The boundary between these, known as the fall-line, is indicated on many easily accessible maps. Each major division can be subdivided, the up-country into mountains and Piedmont, and the coastal plain into several divisions differing in soil and vegetation more than in topography; but there seems to be no satisfactory map of the minor divisions at present. Kerr's map in the 6th volume of the Tenth Census does not separate the mountains from the Piedmont or the sand-hills and Cape Fear region from the rest of the coastal plain; and maps prepared by physiographers (such as the one in Bulletin 96 of the United States Bureau of Soils, and those by Fenneman in the 4th and 6th volumes of the Annals of the Association of American Geographers) do not subdivide the coastal plain rationally. The writer published a sketch map of the coastal plain of North and South Carolina in 1910 and 1917,* but that is now known to be inaccurate in some particulars.

In the next few pages the six divisions recognized will be taken up one at a time, and the principal soil types and series of each listed in order of area. Then to show the influence of soil on other things, the commonest trees will be listed in approximate order of abundance (as determined from the writer's car-window notes chiefly), with technical and common names, and the estimated percentage of evergreens in the forests. The names of evergreens are printed in heavier type. The number of inhabitants per square mile in 1910, the percentage of whites, the percentage of the total area classed as "improved land in farms," the acreage of improved land per inhabitant, and the expenditure for fertilizer in 1909 per acre of improved land in 1910, all of which are more or less definitely related to soil conditions, have been computed from the reports of the last United States census. It would be interesting to carry the investigation back to earlier censuses and

*Bull. Torrey Bot. Club, **37**:407, 592. 1910; **44**:41. 1917.

treat the subject historically, but that would take considerable time, and can be better undertaken by one who lives in the State and is better acquainted with local conditions and history.

THE REGIONS IN DETAIL

1. The mountain region covers about 9,000 square miles in the west end of the State, and is characterized by rugged topography and the highest mountains in eastern North America. Cliffs and other rock outcrops are very limited in extent, however, and almost the whole area would be arable land if it were not for the steepness of the slopes. As it is, over half the area of some of the counties is classed as improved land. Some of the richest soil is in wind-gaps high up on the ridges, and many of the summits are not rocky barrens like some of the mountains in the northern states, but excellent pastures.

The prevailing soil classes in the five or six areas that have been surveyed are loam, sandy loam, clay, black loam, sand, clay loam, and stony loam. By far the greater part of the soils have been referred to the "Porter's" series (named for a mountain in Bedford Co., Va.). Other series represented are the Chandler, Ashe, Toxaway, Talladega, and Clifton.

Apparently not over 15 per cent of the trees are evergreen, which indicates pretty good soils. The commonest species seem to be as follows:

Castanea dentata	Chestnut
Quercus coccinea	Spanish oak
Acer rubrum	Red maple
Quercus borealis maxima (formerly called *Q. rubra*)	
Quercus montana (formerly *Q. Prinus*)	Chestnut oak
Tsuga Canadensis	Hemlock
Pinus Strobus	White pine
Halesia Carolina	
Robinia Pseudacacia	Black locust
Betula lutea	Birch
Fagus grandifolia	Beech
Betula lenta	Birch

In 1910 there were 36.4 inhabitants per square mile in the mountain region, and over 90 per cent of them were white. (Two counties had more Indians than negroes.) The percentage of improved land was

28 (or 4.9 acres per inhabitant), a pretty high figure for such rough country; and the expenditure for fertilizer the preceding year was 13 cents per acre, which is considerably below the average for the United States, and far below the average for North Carolina. The remoteness of much of the region from railroad transportation may not have much effect on the amount of improved land, for the mountaineers are more nearly self-supporting than the residents of other parts of the State, but it undoubtedly does make the consumption of fertilizers less than it would be in a smoother country of equal fertility.

2. The Piedmont region, extending from Pennsylvania to Alabama, covers about one-third of North Carolina. Its rocks are of many varieties, but all metamorphic except for the Triassic areas near the eastern and northern borders (which would be worth treating separately if they were a little larger). Gneiss is perhaps the commonest rock, but there is considerable slate in the southeastern portion. The principal soil types are sandy loam, clay, clay loam, silt loam, coarse sandy loam, fine sandy loam, loam and meadow. They have been referred to fifteen or twenty series, of which the "Cecil" (named for Cecil County, Maryland), covers over half the area. Next in importance are the Durham, Georgeville, Iredell, Alamance, Granville, Congaree, Appling, Caswell, and Mecklenburg (most of which names are of North Carolina origin).

The commonest trees seem to be as follows:

Pinus echinata	Short-leaf pine
Liquidambar Styraciflua	Sweet gum
Liriodendron Tulipifera	Yellow poplar
Pinus Taeda	Short-leaf (or loblolly) pine
Quercus falcata	Red oak
Quercus alba	White oak
Quercus Marylandica	Black-jack oak
Cornus florida	Dogwood
Salix nigra	Willow
Pinus Virginiana	Spruce pine
Betula nigra	Birch
Quercus stellata	Post oak
Quercus Phellos	Willow oak
Oxydendrum arboreum	Sourwood
Platanus occidentalis	Sycamore

About 40 per cent of the total forest is evergreen.

This is the most densely populated portion of the State, having 60.4 inhabitants per square mile in 1910, 70 per cent of them white. The percentage of improved land at the same time was 37.2 (or 5.6 acres per inhabitant), and the average annual expenditure for fertilizers was $1.06 per acre, which is below the State average. The number of cultivated acres per inhabitant is the largest in the State, indicating that agriculture is the dominant industry here, in spite of the great development of manufacturing in recent decades.

3. The sand-hill belt extends from near Sanford southwestward along the fall-line to Georgia. There is some difference of opinion among geologists as to whether the sand that characterizes it is a marine Pleistocene formation or a product of weathering from the underlying Cretaceous strata. The principal soil types are coarse sand, sandy loam, swamp, and sand; and they are nearly all referred to the Norfolk series, with a sprinkling of Hoffman, Orangeburg, etc.

The commonest trees in the North Carolina portion of this belt seem to be:

Pinus palustris	Long-leaf pine
Quercus Catesbaei	Black-jack oak
Quercus Marylandica	Black-jack oak
Pinus Taeda	Short-leaf (or loblolly) pine
Nyssa biflora	Black gum
Liriodendron Tulipifera	Poplar
Pinus serotina	Black pine
Quercus cinerea	
Magnolia glauca	Bay
Liquidambar Styraciflua	Sweet gum
Acer rubrum	Red maple
Taxodium ascendens	Pond cypress

About 60 per cent of these are evergreen. A few of them are strictly confined to the coastal plain, in North Carolina at least, and some others nearly so.

This belt is too narrow to get accurate statistics for, but judging from the returns from Lee, Moore, Richmond, and Scotland counties (and making allowance for the portions of more fertile regions included in those counties) there are about 33 inhabitants per square mile, 62 per cent of them white. The improved land in 1910

amounted to about 15 per cent, or 3 acres per inhabitant, and $1.88 per acre was spent for fertilizer. The small number of acres per inhabitant indicates plainly that this region imports more farm produce than it exports. The money to preserve the balance of trade probably comes mostly from lumber and naval stores, but partly also from winter and spring visitors to Pinehurst and vicinity.

4. What may be called the short-leaf pine belt covers the greater part of the coastal plain in North and South Carolina, and in Virginia south of the James River. Although it exhibits considerable diversity in different parts, the transition from the higher and drier and more fertile portions in the north and west to the more sandy and swampy portions is so gradual that it is difficult to draw any dividing lines. The writer has recently published a somewhat detailed study of the plant population of this region, with some statistics of soils.* Since that paper was written the soil survey reports have been gone over more carefully and the statistics revised a little.

The leading soil types are fine sandy loam, sandy loam, swamp, sand, fine sand, very fine sandy loam, and coarse sand. About 60 per cent of the soils are referred to the Norfolk series, and 15 per cent to the Portsmouth. Other series represented are the Ruston, Coxville, Johnston, Kalmia, Susquehanna, Orangeburg, Hyde, and Congaree.

The commonest trees are about as follows:

Pinus Taeda	Short-leaf (or loblolly) pine
Pinus palustris	Long-leaf pine
Pinus serotina	Black pine
Nyssa biflora	Black gum
Liquidambar Styraciflua	Sweet gum
Taxodium distichum	Cypress
Taxodium ascendens	Pond cypress
Quercus Marylandica	Black-jack oak
Acer rubrum	Red maple
Magnolia glauca	Bay
Liriodendron Tulipifera	Poplar
Quercus falcata	Red oak

About 73 per cent of the forest is evergreen.

*Bull. Torrey Bot. Club, 44:39-57. Feb., 1917.

The density of population in 1910 was 42 per square mile, the percentage of whites 52.6, the percentage of improved land 27.2 (4.1 acres per inhabitant), and the expenditure for fertilizers $2.67 per acre. (The fertilizer bill of Robeson County alone was over a million dollars.) The large expenditure for fertilizer indicates a pretty high development of agriculture on a comparatively poor soil, by an intelligent class of farmers. The acreage of improved land per inhabitant is pretty close to the State average, which probably indicates that the exports of cotton and forest products are about equal.

5. In the southeastern corner of the State is the Cape Fear pine-barren region. It passes by imperceptible gradations into the adjoining short-leaf pine belt, but its boundary may be located approximately by an arc of 35 miles radius with Wilmington as a center. The topography is comparatively level for the most part, and there are many swamps and pocosins and a few savannas. Although no chemical analyses are available, the soils are doubtless the poorest in the State, on the whole, apparently not so much from any fundamental geological cause as on account of the leaching effect of summer rains. At Wilmington 49.4 per cent of the total annual precipitation comes in the four warmest months (June to September inclusive); while at Cape Hatteras, which has a greater total rainfall, only 35.8 per cent falls in those same months.*

The commonest soil types are swamp and muck (largely pocosins), sand, fine sand, fine sandy loam, and very fine sandy loam. About 40 per cent are referred to the Portsmouth series and 25 per cent to the Norfolk, with a scattering of Leon, Hyde, Congaree, etc.

The most abundant trees are the following:

Pinus palustris	Long-leaf pine
Pinus serotina	Black pine
Magnolia glauca	Bay
Pinus Taeda	Short-leaf pine
Gordonia Lasianthus	Bay
Quercus Catesbaei	Black-jack oak
Nyssa biflora	Black gum
Liquidambar Styraciflua	Sweet gum

*See Bull. Torrey Bot. Club, 37:415-416. 1910.

Taxodium ascendens	**Pond cypress**
Taxodium distichum	**Cypress**
Liriodendron Tulipifera	**Poplar**
Quercus Marylandica	**Black-jack oak**
Acer rubrum	**Red maple**

The proportion of evergreens is the highest in the State, about 78 per cent. This region, being a sort of island of poor soil, bordered on the north and west by richer regions, has developed a small endemic flora, with some species almost confined to it (like the noted *Dionaea muscipula*, Venus's fly-trap), and many others more abundant here than anywhere else north of the Georgia pine-barrens. *

In calculating the density of population allowance must be made for the fact that this region contains the State's principal seaport, which is to a considerable extent independent of the surrounding country, and would be a city of some size even if all the soil within fifty miles of it were pure quartz sand. In order, therefore, to get a proper conception of just how much population the Cape Fear region is capable of supporting on its own merits we may leave out New Hanover County and take the figures for Brunswick and Pender only. In 1910 these two had 18.6 inhabitants per square mile, 56.4 per cent of them white, 8.2 per cent of improved land (or 2.8 acres per inhabitant), and spent 99 cents an acre for fertilizers. If New Hanover were included the density of population would be nearly doubled, the percentage of whites and improved land decreased a little, and the expenditure for fertilizers increased to $1.21. The small acreage of improved land per inhabitant is correlated with a large lumber and naval stores industry and commerce.

The fact that this region uses less than half as much fertilizer per acre as the evidently more fertile short-leaf pine belt may seem like a paradox; but the explanation is doubtless that agriculture is still in its infancy here, and only the richest spots are farmed, as was the case in the long-leaf pine country of Georgia a generation or two ago. By the time the percentage of improved land becomes as great here as it is now in the short-leaf pine belt no doubt a great deal more will have to be spent for fertilizers. But it would seem possible for such a

*See Bull. Torrey Bot. Club, **34**:365. 1907.

sandy region to attain a considerable development of agriculture with very little fertilizer by taking a lesson from Denmark, and importing hay and grain to feed to cattle and chickens, and exporting only things that take little or nothing from the soil, such as turpentine, honey, syrup, butter, and eggs.

6. What was designated by Kerr as the "oak and beech flats with short-leaf pine" occupies the northeastern corner of the State, east of the Nansemond escarpment, which runs almost due south from Suffolk, Va., and forms the western border of the Dismal Swamp. It is a low and flat and rather swampy region, but has probably the richest soils of any region so near the coast between Virginia and Louisiana. The amount of silt in the soil is remarkably high, and the region has somewhat the aspect of an alluvial bottom. It was indeed referred to as "bottom-land" by some of the early settlers.

There are as yet no soil surveys for the portion south of Albemarle Sound, except for Lake Mattamuskeet and its immediate shores, so the following soil data pertain only to the northern half, which is the more fertile, if the census statistics are a reliable indication. The prevailing soil types are silt loam, fine sandy loam, swamp, and loam. About four-fifths are referred to the Portsmouth series and the rest to the Norfolk (aside from Swamp, which is not put in any series). There is apparently no other area of the same size anywhere in the United States east of the Blue Ridge that has such a large proportion of silt loam.

The list of trees likewise pertains only to the northern half, for the writer has never visited the southern half, which has very few railroads. The following list is based on car-window notes taken between Edenton and the State line near Moyock, and therefore does not include any of Dismal Swamp.

Pinus Taeda	Short-leaf pine
Liquidambar Styraciflua	Sweet gum
Taxodium distichum	Cypress
Acer rubrum	Red maple
Fagus grandifolia	Beech
Pinus serotina	Black pine
Nyssa biflora	Black gum
Nyssa uniflora	Tupelo gum

Salix nigra	**Willow**
Quercus Phellos	**Willow oak**
Liriodendron Tulipifera	**Poplar**

Only about 38 per cent of the trees are evergreen, which is a low figure for the coastal plain. The beech, which one is inclined to associate with bluffs and ravines, seems to be more abundant here than in any other equal area in the State.*

Statistics of population and agriculture have been computed separately for the portions of this region north and south of Albemarle Sound. In the northern portion, in 1910, there were 41.6 inhabitants per square mile, 54.4 per cent of them white, 28.2 per cent of improved land (4.4 acres per inhabitant), and $1.39 per acre spent for fertilizers the previous year. The corresponding figures for the southern half are 13.7 per square mile, 69 per cent white, 6.8 per cent of improved land (3.3 acres per inhabitant), and 88 cents per acre for fertilizers. The figures for improved land per capita confirm the general impression that many of the inhabitants in the southern part depend on lumbering, fishing, stock-raising, etc., for a livelihood; and the small expenditure for fertilizers in that part can probably be explained in the same way as in the Cape Fear region.

STATISTICAL SUMMARY

Some of the statistics given in the foregoing regional sketches will now be brought together in a table for purposes of comparison, and supplemented by similar figures for the up-country and low country collectively, and for the whole State and the whole United States. The first five lines of figures have been computed from the 13th census, as already indicated, and two sets are given for the fifth and sixth regions, to show conditions in the Cape Fear region with and without New Hanover County, and for the northern and southern parts of the northeastern swamp region separately.

In the 6th line the percentage of evergreens has been estimated pretty carefully for region 4, but is only a rough guess for the others.

*According to Fernald and Rehder (Rhodora 9:112-114. 1907), the coastal plain beech is varietally distinct from the one in the mountains and northward; though they certainly look much alike. It would be interesting to determine if there is a gap between the ranges of the two forms. The fact that in the mountains of North Carolina beech is chiefly confined to the higher elevations suggests such a possibility.

The significance of the evergreen percentage is that it seems to vary inversely with soil fertility, in the eastern United States at least. *

The soil types are arranged as nearly as possible in order of increasing fineness, and the percentages are given for each, to the nearest tenth. To simplify matters some similar classes have been combined, such as rock outcrop and rough stony land; sand, sand-hill, and coastal beach; stony, gravelly, and slate loam; and swamp, muck, and meadow. Marsh (tidal or salt marsh), however, is kept separate. Percentages less than 1-20 are represented by 0, but where a given type of soil is not reported at all from a given region the space is left blank. The soil statistics for the whole United States are taken from Bulletin 96 of the Bureau of Soils, page 10. (That, however, uses a very generalized classification, with only eight types.)

	Mountains	Piedmont	Sandhills	Short-leaf Pine Belt	Cape Fear Region	Do. Without New Hanover County	Oak and Beech Flats		Up-country	Low Country	Whole State	Whole U. S.
							N.	S.				
Inhabitants per sq. mile	36.4	60.4	33.0	42.0	34.0	18.6	41.6	13.7	51.9	38.7	45.3	30.9
Per cent white	91.7	70.0	62.0	52.6	52.2	56.4	54.4	69.0	75.6	53.8	68.0	88.9
Improved land, per cent.	28.0	37.2	15.0	27.2	8.1	8.2	28.2	6.8	33.7	23.2	28.3	25.1
Improved land per inhabitant	4.9	5.6	3.0	4.1	1.5	2.8	4.4	3.3	4.1	3.8	4.0	5.2
Fertilizer per acre	.13	1.06	1.88	2.67	1.21	.99	1.39	.88	.80	2.47	1.39	.24
Percentage evergreens	15	40	60	73	78		38	?	30	70	51	?
SOIL CLASSES												
Rock outcrop, etc.	1.0	0.1							0.4		0.2	?
Coarse sand			70.1	2.0						5.5	2.8	5.0
Sand, etc.	5.4		6.8	12.3	20.3				1.5	12.4	7.0	
Fine sand		0.1		4.4	19.1	2.0			0.	6.1	3.2	4.2
Stony sandy loam, etc.		0.3	1.9	0.					0.2	0.1	0.2	?
Stony loam, etc.	2.0	1.9							1.9		0.9	?
Coarse sandy loam		8.6	0.3	1.7	0.3				6.3	1.4	3.8	10.2
Sandy loam	20.6	31.6	11.7	28.2	3.8				28.6	21.8	25.2	
Fine sandy loam	1.6	7.3		29.9	15.3	26.3			6.0	25.7	16.0	16.2
Very fine sandy loam				2.1	13.7					3.6	1.8	
Loam	42.7	3.8	0.3	0.9	3.1	14.3			14.2	2.0	8.0	17.4
Silt loam		12.2		1.7	1.8	40.0			9.0	4.0	6.4	27.0
Silty clay loam		1.9							1.4		0.7	10.7
Clay loam	4.9	14.3		0.					11.9	0.	5.8	
Black loam	8.4								2.2		1.1	?
Clay	12.1	14.9		1.8	0.				14.2	1.4	7.6	9.3
Swamp, etc.	1.1	3.0	9.0	15.0	20.6	17.4			2.5	15.6	9.2	?
Marsh				?	1.9	?				0.3	0.1	?

*See Science II. 42:500-503. Oct. 8, 1915.

Some of the relations between soil conditions and density and color of population, improved land, fertilizers, and evergreens are brought out pretty well by the upper part of the table, but some disturbing factors of topography and climate have to be borne in mind. Some of these have already been mentioned. In the South negroes and rich soils generally go together, but on account of the mountains and upper part of the Piedmont being too cool for cotton, the proportion of negroes is less there than in regions of equal fertility farther south. The amount of improved land is pretty closely correlated with soil fertility except in the mountains, where topography interferes. The probable reasons for the small consumption of fertilizers in regions 1, 5, and 6 have already been mentioned.

The statistics of population, race, and improved land seem to indicate that the short-leaf pine belt has better soils than the sand-hills, while those for fertilizers and evergreens point the other way. Chemical analyses might throw some light on this paradoxical problem.

Considering now the soil texture statistics, there seems to be no area of rock outcrop or rough stony land large enough to map in the coastal plain of North Carolina (and the same might be said of the states farther north, but not of Georgia, Florida, and Alabama). Coarse sand is chiefly confined to the fall-line sand-hills. Sand and fine sand are most abundant in the Cape Fear region; and the fact that there is more sand in the mountains than in the Piedmont may be correlated with the heavier summer rains in the mountains. The various grades of sandy loam taken together are pretty evenly distributed over the State, except in the sand-hills, where the necessary clay component is scarce.

Fine sand and fine and very fine sandy loam are not common in the up-country, being more characteristic of regions where there is very little erosion going on. Loam is most abundant in the mountains and silt loam at the other end of the State, as already indicated; but just why, it is not easy to say. Clay is about ten times as common in the up-country as in the low country, just the reverse of sand and swamp; the principal reason presumably being that weathering has been going on much longer in the up-country.

COLLEGE POINT, NEW YORK.

POLLINATION OF THE ROTUNDIFOLIA GRAPES

By L. R. Detjen

Notwithstanding the fact that much work has been accomplished with the species *Vitis rotundifolia*, the subject of the pollination of these vines seems as little understood as ever. Persons who know the Scuppernong and other varieties of rotundifolia grapes and who have studied them for many years are very much impressed with the mysterious way in which the flowers of these varieties get the necessary viable pollen for fruit production. Time and again cases are cited where certain vines annually produce large crops of fruit, and only a very few, if any, insects are observed to visit such vines.

A vine with self-fertile flowers, under normal conditions, will usually produce at least an average crop of fruit, and there is nothing mysterious about the method in which the flowers of such vines are pollinated.

Considerable evidence collected by the North Carolina Experiment Station (Bulletin No. 209, on the "Self-sterility of Scuppernong and other Muscadine Grapes"), and corroborated by the results subsequently secured and published in "The Breeding of Rotundifolia Grapes," Technical Bulletin No. 10, and by Husmann and Dearing, (United States Department of Agriculture, Bureau of Plant Industry, Bulletin No. 273), seems to establish the fact that the present-day commercial varieties of rotundifolia grapes are self-sterile. This fact, then, calls for an explanation of how the different varieties are being supplied with sufficient viable pollen which is necessary to account for the large crops of fruit that are annually produced.

Flowers in general, that require cross-pollination, may for convenience be grouped into two general classes: (1) those that are wind-and-water pollinated and (2) those that are insect-and-bird pollinated. The flowers of the first class generally are deficient in odor, nectar glands, and bright colors.

For self-evident reasons we may omit in our present discussion water and birds as agents in the transportation of grape pollen.

Among wind-pollinated flowers we usually find prevailing a type of pistil with a comparatively long style and a feathery stigma, the

function of which is to catch wind-borne pollen. Such pistils are not associated with flowers of *Vitis rotundifolia.*

Pollen that depends on wind for its successful distribution is usually of a light and dry character. This is especially true among dioecious plants where the stamens and pistils of the flowers are borne on separate plants, and where the pollen must often be carried long distances in order to reach the pistillate plants.

On the contrary, flowers that depend on insects for the transportation of pollen generally produce pollen grains which have a waxy surface, and which, therefore, will easily cling to the hairs and other parts of insects with which they may come in contact. Very often, instead of having a waxy coat, the pollen grains are flattened, angular, or may be covered with spiny protuberances which materially assist the pollen grains to adhere to foreign objects. Nectar glands, odors, or bright colors are usually well developed, by means of which insects might easily be attracted.

That the flowers of rotundifolia grape vines depend mainly on insects for the transportation of this pollen becomes more apparent the closer we examine the individual parts of the flowers. The floral parts that indicate cross-pollination by insects, and which we shall briefly discuss here, are the following: (1) character of pollen, (2) odor, and position of flowers on vine, (3) nectar glands, and (4) character of the pistil in the flower.

By dipping a dry camel's-hair brush into a vial of freshly gathered rotundifolia grape pollen one can easily detect the waxy coat of the pollen grains. The hairs become dusted with the powdery element, and vigorous jarring alone will dislodge the pollen grains from the brush.

While the flowers of neither the staminate nor of the imperfect hermaphrodite vines are of a showy character, insects are quickly attracted to them because of their penetrating sweet odors. This is especially important to the flowers, because many of them are located deep under the leafy canes where, but for the sweet odors, they might go unnoticed and therefore unpollinated. Not only is the pollen very fragrant, but nectar is secreted by glands, five or more, which are

situated between the stamens at the base of the pistil. In the staminate flowers the glands cover the greater part of the upper surface of the receptacle, while in the imperfect hermaphrodite flowers they form almost a continuous ring of glandular tissue at the base of the ovary.

The pistils of the grape flowers, because of their small size, are not well adapted to catch wind-borne pollen, and the position of many flower clusters under dense foliage makes it practically impossible for them to catch pollen that is carried by the wind.

The evidence presented seems quite sufficient to exclude wind as the principal agent in the pollination of rotundifolia grape vines, and points out clearly that this great work is laid at the feet of some humble insect.

INSECTS OBSERVED ON OR ABOUT ROTUNDIFOLIA GRAPE VINES

What insect or insects accomplish the pollination of the fruit-bearing rotundifolia grape vines always has been a matter of speculation. The North Carolina Experiment Station Bulletin No. 209 mentions "honey bees" and "various flies" as being the most important carriers of pollen. Husmann and Dearing (U. S. Dept. Agr., Bureau of P. I. Bulletin No. 273) mention a small "long-horned beetle, *Copidita thoracica*," and a small "bee-like fly" as being the most active among pollen carriers.

It is true that many insects frequent the more exposed flower clusters of staminate vines, but not so many can be observed to explore the inner and deeper recesses of dense, foliacious fruit-bearing vines when in search of pollen and nectar. While the exposed flower clusters are most easily accessible to insects and more fruit is produced on these clusters, nevertheless, very fine and luscious fruits are not infrequently gathered from the most leafy parts of the vine. This fact seems to indicate that the flowers of the fruit-bearing vines are diligently sought out by some active insect, presumably for the nectar.

Among the insects that were observed to visit the flowers of fruit-bearing rotundifolia grape vines the following are deemed the most important: (1) short-tongued or mining bees (Fam. *Andrenidæ*), (2) bees of the family *Megachilidæ*, (3) honey bees (*Apidæ*), and (4) a soldier beetle (*Chauliognathus marginatus*).

By a comparative study of all the insects that visit the staminate and perfect flowered rotundifolia grape vines, the source of all viable pollen, we come to the conclusion that bees are the best adapted for the transportation of pollen. Their bodies are densely covered with branched hairs where the pollen grains become entangled and thus are carried about from flower to flower. Most of the bees possess specialized hairs, either on their last pair of legs or on their abdomen, which hairs are collectively spoken of as "pollen baskets." These specialized devices at times are so filled with pollen that the yellow masses can be seen at some distance. Of course, these pollen baskets are not such mechanical devices from which no pollen ever escapes or is lost; on the contrary, when the bee rambles over the flower in search of more pollen and nectar, these baskets come in contact with the moist stigmatic surfaces of the pistils and thereby lose a part of their contents. A sufficient number of the pollen grains are thus caught and held by the pistils to effect fertilization, and fruit production is the result.

The bees that were most commonly observed on flowers of both types of vines were of the group known collectively as short-tongued or mining bees. Very often, and probably more commonly, these insects are known by the name of "sweat bees" because of the persistence with which they hover about perspiring field laborers. These insects are small and light, which enables them to travel rapidly over the flower clusters, and their bodies and legs, being short, causes them to come in close contact with the pistils every time they try to get nectar. Their flight from vine to vine, and from cluster to cluster, is so rapid and so noiseless that, unless actually observed, one would not even suspect their presence on the vine.

Under these conditions it is no longer a miracle that the flowers on rotundifolia grape vines become pollinated and bountiful crops of fruit are produced.

Bees of the family *Megachilidæ*, and honey bees (*Apidæ*) also have been observed to visit both types of flowers of the rotundifolia grapes. Of these, the former are probably the more important, and this for two reasons: (1) because they were observed to be more frequent visitors, and (2) because their pollen-carrying apparatus is larger and

so well situated that all the flowers over which they travel are bound to become pollinated.

Instead of having pollen baskets on the legs like most of the others, these bees carry pollen in baskets that are situated on the ventral side of the abdomen. In fact, nearly the whole underside of the abdomen bears specialized hairs which collectively form the large pollen basket.

Honey bees have been observed in very small numbers to frequent the flowers of fruit-bearing vines, and therefore they should be classed as of less importance in regard to the pollination of rotundifolia grape vines.

Beetles generally are poor pollinators, and this for two reasons: (1) because their bodies are generally smooth—specialized hairs for carrying pollen are not known to occur on beetles—and (2) their slow progress from flower to flower is too clumsy a means of transportation where many flowers are to be pollinated daily.

Among the beetles that were most commonly observed on flowers of the grapes, *Chauliognathus marginatus* was the most abundant always. The body covering of this beetle is minutely hirsute, and with the aid of a hand lens one can very often see adhering pollen grains, especially about the regions of the thorax and legs. The beetle is a voracious feeder on pollen, and frequently has been observed to devour the entire stigma and style of the flowers. This habit of the beetle would brand him rather a destroyer than a producer of fruit crops. However, it is possible that during his rambles he may scatter enough pollen to class him among the pollinators of the vine.

Other beetles that were observed to feed on grape pollen are the following: a small black blister beetle, twelve-spotted cucumber beetles, and striped cucumber beetles. These were seen only in exceedingly small numbers, and judging from their habits they are unimportant as far as the pollination of the grape is concerned.

While flies of many species were observed to be on the flowers of staminate vines, only a very few ever visit the flowers of the fruit-bearing vines. The habits of these small flies are such that pollen seldom clings to their bodies, and therefore with them the transportation of pollen becomes a negligible factor.

EXPERIMENTS CONDUCTED WITH INSECTS

In order to try out the efficiency of insects as pollinators of the grape, two groups, that had been observed frequenting the flowers of both types of vines, were selected, and the results obtained are made the basis of this presentation. The two groups of insects thus chosen are (1) the short-tongued or mining bees of the family *Andrenidæ,* (2) a soldier beetle, *Chauliognathus marginatus.* Of these two groups of insects, the bees seemed the more important because of the immense loads of pollen that they gather and carry from flower to flower, and because of their pronounced greater activity among the flowers. In the spring of 1916 the mining bees were observed to be by far the most numerous visitors on all types of rotundifolia grape vines. The second group, *C. Marginatus,* for many years has been observed to be very abundant among the flowers, and because of their somewhat hirsute coat they were considered worthy of investigation.

The methods used to test these insects as to their propensities for hunting out and pollinating rotundifolia grape flowers may be described as follows: Suitable flower clusters were selected and prepared, by removing all the open flowers, and then inclosed in cloth bags of varying sizes. Usually on the following day the flowers began to open and were ready for pollination. The insects were captured alive on a staminate vine by means of a glass test tube and immediately liberated within the cloth bags, one insect to the bag per day. The bags were then re-tied and the inclosed flowers were left to their fate.

The cloth bags were conveniently large and allowed the imprisoned insects plenty of space to avoid crossing the flower clusters if the insects took such a notion. The smallest bag measured no less than 6x12 inches and the largest bag 12x18 inches.

Twelve of such bags were used on a Sanmonta vine, twelve on a James vine, and five on a fruit-bearing seedling vine. In each case two of the bags were retained as a check on the results that might be obtained in the other bags. It was the intention originally to have all of the bags cover flowers on the same variety, but as the work was done during the latter part of the blooming season, a lack of sufficient flower clusters on one variety made it necessary to utilize several.

The ultimate result, a normal typical fruit cluster, should be obtained in each case.

It so happened that the bees were liberated in the bags which covered flowers of Sanmonta, and the beetles in the bags which covered flowers of James and of the seedling vine. In the case of the ten bags on Sanmonta and of the ten bags on James, the captive insects were simply liberated within these bags; but in the case of the bags on the seedling vine the beetles were actually brushed, although lightly, over the flowers and the beetles themselves were thrown away. It will be noticed that the work on this last vine was simply to find out whether the beetles actually carried viable pollen on their bodies and whether this pollen might be easily detached and thus pollinate flowers over which the insects traveled. The results of the experiment are indicated in the following table:

Bags	Bees (Fam. Andrenidae) on Sanmonta		Beetles (Chauliognathus marginatus) on James		Beetles (Chauliognathus marginatus) on Seedling	
	Number Fl. Clusters	Number Berries	Number Fl. Clusters	Number Berries	Number Fl. Clusters	Number Berries
1	1	11	1	0	1	1
2	2	35	1	0	1	
3	2	32	1	0	1	13
4	2	37	1	0		
5	1	18	1	0		
6	1	15	1	0		
7	1	33	1	0		
8	1	14	1	2		
9	2	37	2	7		
10	1	28	1	4		
Totals	14	280	11	13	3	14

From the above table we learn that the short-tongued or mining bees proved to be by far the more effective in the dissemination of pollen and the production of fruit. Every bag into which bees had been placed contained at least some fruits, and in most cases good size typical clusters.

The effect of the beetles is not so marked. Seven of the bags which had contained a beetle apiece did not set a single fruit. The three remaining bags contained two, seven, and four berries respectively.

The effect of brushing newly caught beetles over receptive flowers was a little more marked. One of the bags contained one berry, one contained no fruit, and the third contained a cluster of thirteen berries.

The check bags, six in all, two on each variety, contained not a single berry. This result simply indicates the self-sterility of the vines in question.

SUMMARY

Judging from the types of insects and of their numbers that were observed to visit flowers of the rotundifolia grape vines, it may be stated that bees constitute the most important group. Of this great group, the short-tongued or mining bees (Family *Andrenidæ*) sometimes known as "sweat bees," are the most important, and chiefly responsible for the cross-pollination of all varieties.

Bees of the family *Megachilidæ* have been observed to visit flowers of the fruit-bearing rotundifolia grape vines and are responsible for the pollination of many flowers. Because of the smaller numbers of these bees, however, they are of only secondary importance to those of the family *Andrenidæ*.

Honey bees (Family *Apidæ*) have been observed in but very small numbers on vines of the fruit-bearing kind, and, while they may effect some cross-pollination, are relatively unimportant in the production of regular fruit crops. This contention is borne out by the poor results that were obtained in large commercial vineyards where honey bees were kept for the sole purpose of cross-pollination.

Several species of beetles have been observed to feed on pollen from rotundifolia grape vines. Of these, *Chauliognathus marginatus* has in a limited way shown itself capable of cross-pollinating grape flowers. The effect of these beetles on the regular fruit crop, however, is so slight that they need not be given much consideration as pollen carriers.

Flies, from their very habit and character, do not produce noticeable, if any, cross-pollination of the rotundifolia grape vines, and can be safely ignored in regard to the pollination of the grape.

RALEIGH, N. C.

THE DIORITES NEAR CHAPEL HILL, N. C.

By John E. Smith

It is generally believed, and frequently stated, that diorites are not common in the United States; and such is true of certain large areas. In North Carolina, Virginia, and I believe in the Piedmont and in the Blue Mountains south of the Potomac River, relatively large areas of this rock are found, being known in Caldwell, Rowan, Forsyth, Caswell, Alamance, Orange, and other counties in North Carolina. In this State, however, the diorites on the average constitute not more than one-tenth of the igneous rocks and are irregularly distributed throughout the Piedmont and Mountain sections. These occur as strips or in belts, and sometimes in small circular areas, lying parallel to the direction of the strike, which is in general northeast and southwest. These belts or stocks vary in size up to three miles or more in width and up to a length of ten to twenty miles or more. Some of them are ribbon-like in shape, some are irregularly ellipsoidal, and part of the finer grained ones occur as schlieren and possibly as dikes in granite.

A stock of "granite" extends along the southeastern edge of Orange County. On the west of this a belt of diorite parallels the granite with which it is in contact, passing through Carrboro just west of Chapel Hill. West of this belt of diorite the schists dip sharply to the northwest and the sheeted structure in the diorite lies normal to this dip. One set of joints is approximately parallel to the dip and the other nearly normal to it. Both dip faults and strike faults occur in or near this belt of rocks, and dikes are found cutting it in various places. These dikes consist chiefly of basic rocks and vary in size from one foot up to fifteen feet or more in width, a few being much larger than this. Veins of secondary minerals, such as calcite, quartz, and epidote, also occur in the diorite. The veins of calcite and epidote are very narrow, seldom exceeding an inch in width, but the quartz veins sometimes reach a size of two feet or more. Near the contact margin between the diorite and the granite inclusions of the former occur frequently in the latter, showing the greater age of the diorite.

Within the belt of diorite occur long narrow lenses of gabbro, some of which have a maximum width of four hundred yards and are half a mile or more in length.

PETROGRAPHY

In hand specimens the rock is coarsely holocrystalline, granitic, but sometimes occurs in finer-grained texture, with about equal amounts of light and dark minerals. In a few places porphyritic texture is developed in limited areas and also irregular spherical areas of granite a few feet in extent. In the schlieren the texture is finer grained, but holocrystalline and the dark minerals predominate. Within three feet of these segregations the texture is somewhat gneissoid, the layers being roughly parallel to the border of the dark "patches," which in some cases are circular in outline.

Microscopic examinations were made of typical specimens taken from the outcrop at the foot of Clover Hill near the new bridge on the Hillsboro road. In this section the crystals of the diorite are seen to be hypidiomorphic in form. Oligoclase is the predominating mineral, approximating 40 per cent of the total. The hornblend nearly equals the feldspar in quantity, and with 15 per cent of epidote, about 5 per cent of quartz, a small amount of albite, and the accessory minerals, apatite, zircon, and magnetite, makes up the remainder of the rock. Oligoclase and the accessory minerals have the most distinct crystal boundaries.

Between crossed Nicols the oligoclase crystals almost without exception are seen to inclose a central rectangular area of minute indeterminable inclusions. These areas are surrounded by clear border zones having about one-fifth the width of the crystals and exhibiting clearly narrow parallel striations due to polysynthetic twining. Rarely can striations be seen among the inclusions. In a few instances medium-size crystals show only a single circular row of inclusions inward from the margin about one-fourth the width of the crystal. Numerous needles of apatite occur largely as inclusions in the plagioclase crystals. Only one crystal was seen to exhibit faulting, and a few small patches of micropegmatite were observed. The faulting seen in this crystal was caused by crushing after the rock solidified.

and was probably obtained near a fault plane. The porphyritic phase of the diorite exhibits long, narrow phenocrysts of green hornblend in a matrix similar to the other portions of the rock. The order of crystallization is as follows: apatite, magnetite, oligoclase, hornblend, and quartz.

The following analyses of the diorite showing the chemical composition of the rock were made by Mr. W. L. Goldston, Jr.:

No.	SiO_2	Al_2O_3	FeO Fe_2O_3	CaO	MgO	P_2O_5	SO_3	K_2O Na_2O_3	H_2O	Total
1	53.25	17.72	4.65	9.82	1.22	1.75	.89	9.81	.62	99.73
2	62.97	15.90	2.75	8.46	2.24	.78	.77	3.60	2.75	100.22

No. 1 is the fresher rock at the base of Clover Hill. No. 2 is the altered product of it from an elevation about thirty feet higher.

PETROGRAPHIC RELATIONS

This area is on the eastern margin of the "Schist and Slate Belt," which in every county where it occurs is broken by igneous rocks. The long stock of "granite," which includes members of the diorite, gabbro, and peridotite families, passing through southeastern Orange County, constitutes a petrographic province of much interest. It is everywhere cut by dikes chiefly of basic rocks, including basalt, diabase, limburgite, and limburgite porphyry and some unidentified dark-colored rock very fine-grained in texture. The "Iron Mine" is located just beyond the main belt of diorite, to the northwest. That this body of mineral, chiefly magnetite and hematite, is a dike (a series of dikes northward) is shown by the apophyses entering the weathered wall-rock from it and by the upward curved foliæ of the schisted wall-rock in contact with it. As far as they have been identified, the dike rocks are chiefly complementary.

Granite, at Chapel Hill, one-fourth mile from diorite belt. In this section the following minerals are shown to be present: quartz, microcline, oligoclase, hornblend, epidote, and pyrite. Inclusions are seen in quartz, oligoclase, and microcline. The oligoclase crystals have the usual clear narrow border, with parallel striations, inclosing a large inner area of minute indeterminable inclusions which make

up the major portion of the areas of the crystals. There are inclusions of hornblend in some of the microcline. The hornblend occurs sparingly and is partially altered to chlorite. Epidote is present as a secondary mineral.

Syenite near margin of diorite. This section shows the rock to be chiefly oligoclase, with distinct crossed lamellæ in most of the crystals. The inclusions are coarser than those in the granite, and in some instances are oriented in two directions, parallel to each set of the crossed lamellæ. The clear margins of the crystals of oligoclase are about one-tenth the width of the crystal. Small amounts of hornblend, epidote, quartz, and apatite are present.

These and other sections examined reveal the fact that there is a somewhat uniform decrease of quartz and microcline toward the diorite from Chapel Hill and a corresponding increase of oligoclase and hornblend.

ORIGIN

The coarse granitic texture of the rock is sufficient evidence of its plutonic origin. The lens of gabbro at Carrboro and that half a mile northwest of Clover Hill, lying wholly within the belt of diorite and parallel to its principal direction, suggest magmatic segregation as the origin of the gabbro. This, with the relation of the diorite to the granite on the southeast, suggests that the entire group of rocks constitute a stock the long and narrow members of which were derived by differentiation as the magma solidified. The central axis of this stock probably lies along the area of pink granite half a mile or more from the diorite. This origin would also account for the schlieren in the granite and for the spots of granite in the diorite. It is younger than the schists, slates, etc., having cut and folded them, and older than the Triassic sediments resting unconformably on it to the east. Though usually considered as Archean, it is not definitely known to be of that age.

ALTERATION

From the chemical analyses given it will be seen that the silica and water content increase and that the alkalis decrease as the process of weathering proceeds. Examination of the rock in thin section re-

veals the fact that the oligoclase, hornblend, and magnetite on decomposition give rise to epidote, albite, calcite, and limonite. It is not probable that all of these minerals occur throughout the diorite belt; in one place calcite veins are found; in another veins of quartz, and elsewhere veins of epidote. The chief processes involved in these changes are hydration and carbonation, which, with oxidation, disintegration, etc., and the additional work of organic agencies, with some sedimentary material, form the soils known as the Iredell series.

CHAPEL HILL, N. C.

LIST OF PLANTS FROM BATESBURG, S. C., AND VICINITY

By E. A. McGregor

While stationed at Batesburg, S. C., for a period of five years, at which point I was engaged in the investigation of the common red spider, I utilized some of my spare moments in the collection of the native plants of that locality. The results are recorded in the list that follows. I may say that the collection was almost entirely named by the systematic staff of the Bureau of Plant Industry of the United States Department of Agriculture. The collection is now a part of the Dudley Herbarium at Stanford University.

POLYPODIACEÆ

Polypodium polypodioides (L.) Hitche. January 10, 1915; July 16, 1915.
Lorinseria areolata (L.) Presl. August 20, 1913.
Athyrium Filix-femina (L.) Roth.
Polystichum acrostichoides (Michx.). Scott.

PINACEÆ

Pinus taeda (L.). May 12, 1914.
Pinus rigida Mill. May 12, 1914.
Pinus virginiana Mill. May 12, 1914.
Pinus echinata Mill. May 12, 1914.
Pinus palustris Mill. May 12, 1914.
Chamaecyparis thyoides (L.) BSP. Steedman, S. C. May 30, 1913.

THYPHACEÆ

Typha latifolia L. August 12, 1915.

POACEÆ

Paspalum angustifolium LeConte. July 15, 1913.
Paspalum glabratum Engelm. July 31, 1915.
Panicum scoparium Lam. June 25, 1915; August 20, 1913.
Panicum anceps Michx. July 31, 1915.
Panicum Boscii Poit. May 11, 1912.
Panicum commutatum Schult. May 11, 1912.
Panicum xalapense H. B. K. April 16, 1913; May 24, 1913; May 6, 1912.
Panicum microcarpon Muhl. July 20, 1913.
Phleum pratense L. June 25, 1915.

Holcus halepense (L.) Pers. July 15, 1914; August 1, 1915.
Poa annua L. April 21, 1914.
Dactyloctenium aegyptium (L.) Richter. August 12, 1915.
Arundinaria tecta (Walt.) Muhl. July 31, 1915.

CYPERACEÆ

Cyperus pseudovegetus Stend. July 15, 1913.
Cyperus strigosus L. August 1, 1913.
Eleocharis tortilis (Link.) Schultes. July 15, 1913.
Carex stipata Muhl. May 6, 1912.
Carex lurida Wahl. May 24, 1913.
Carex intumescens Rudge. April 16, 1911.
Carex verrucosa Muhl. August 20, 1913.

ARACEÆ

Arisaema triphyllum (L.) Schott. April 21, 1912.
Orontium aquaticum L. Steedman, S. C. May 16, 1914.

ERIOCAULACEÆ

Dupatya flavidula (Michx.) Ktze. May 30, 1913.

JUNCACEÆ

Juncus scirpoides Lam. June 25, 1915.
Juncus debilis A. Gray. May 6, 1912.
Juncus acuminatus Mx. April 16, 1911.

LILIACEÆ

Chamaelirium luteum (L.) Gray. July 15, 1913; May 12, 1914.
Oakesia sessilifolia (L.) Wats. April 4, 1911.
Allium canadensis L. May 24, 1912.
Allium mutabile Michx. May 20, 1913; May 30, 1913.
Muscari racemosum (L.) Mill. August 12, 1915.
Yucca filamentosa L. July 15, 1914.
Polygonatum commutatum (R. & S.) Dietr. April 29, 1911.
Smilax rotundifolia L. April 24, 1912.
Smilax laurifolia L. April 24, 1913.
Smilax pseudo-China L. April 29, 1911.
Nemexia Hugeri Small. July 31, 1915.

AMARYILLIDACEÆ

Hypoxis hirsuta (L.) Coville. April 29, 1911.

IRIDACEÆ

Iris versicolor L. May 13, 1913.
Sisyrinchium fibrosum Bicknell. April 24, 1912; May 6, 1912.
Sisyrinchium sp. April 16, 1911.

ORCHIDACEÆ

Gymnadeniopsis clavellata (Michx.) Rydb. August 20, 1913.
Pogonia ophioglossoides (L.) Ker. Steedman, S. C. May 16, 1914.
Limodorum tuberosum L. Steedman, S. C. May 30, 1913.
Spiranthes cernua (L.) Richard. June 15, 1912.
Tipularia unifolia (Muhl.) BSP. August 30, 1913.

SALICACEÆ

Salix nigra Marsh. July 16, 1915.

JUGLANDACEÆ

Juglans nigra L. July 31, 1915.
Carya ovata (Mill.) K. Koch. July 31, 1915.

BETULACEÆ

Alnus rugosa (Dupoir) K. Koch. April 24, 1913.

FAGACEÆ

Quercus virginiana Mill. April 26, 1914; August 1, 1913.
Quercus nigra L. Steedman, S. C. May 16 1914.
Quercus nigra L. August 1, 1913.
Quercus alba L. August 1, 1913.
Quercus stellata Wang. Steedman, S. C. May 16, 1914.

URTICACEÆ

Celtis georgiana Small. July 31, 1915.
Boehmeria cylindrica (L.) Sw. August 20, 1913; September 7, 1911.

LORANTHACEÆ

Phoradendron flavescens (Pursh) Nutt. June 25, 1915.

POLYGONACEÆ

Rumex obtusifolius L. July 15, 1911.
Rumex crispa L. August 12, 1915.
Rumex acetosella L. April 18, 1911.

Polygonum Sp. May 6, 1914.
Persicaria Persicaria L. August 12, 1915.
Persicaria hydropiperoides (Michx.) Small. June 15, 1912.

CHENOPODIACEÆ

Chenopodium Botrys L. August 20, 1913.
Chenopodium album L. July 31, 1915.

AMARANTHACEÆ

Amaranthus spinosus L. July 31, 1915.
Amaranthus hybridus L. August 12, 1915.
Amaranthus retroflexus L. July 31, 1915.

PHYTOLACCACEÆ

Phytolacca decandra L. May 24, 1912.

CARYOPHYLLACEÆ

Stellaria media (L.) Cyrill. June 10, 1915.
Silene antirrhina L. May 9 1914.

NYMPHAEACEÆ

Castalia odorata (Dryand.) W. & W. Steedman, S. C. May 30, 1913.

RANUNCULACEÆ

Ranunculus pusillus Poir. April 16, 1911.
Clematis viorna L. April 16, 1911.
Actaea alba (L.) Mill. July 31, 1915.

MAGNOLIACEÆ

Magnolia virginiana L. May 24, 1912.

CALYCANTHACEÆ

Calycanthus floridus L. May 6, 1912.

ANONACEÆ

Asimina triloba (L.) Dunal. May 24, 1913.

CRUCIFERÆ

Lepidium virginicum L. June 10, 1915.
Coronopus didymus (L.) Sm. May 6, 1914.
Brassica oleracea L. April 21, 1914.
Sisymbrium Thalianum (L.) Gay. April 24, 1912; May 2, 1914.

SARRACENIACEÆ

Sarracenia rubra Walt. May 16, 1914.

DROSERACEÆ

Drosera intermedia Hayne. Steedman, S. C. May 30, 1913.

CRASSULACEÆ

Penthorum sesoides L. July 15, 1913.

SAXIFRAGACEÆ

Heuchera americana L. May 12, 1914.
Itea virginica L. May 13, 1913; May 12, 1914.

HAMAMELIDACEÆ

Liquidambar styraciflua L. May 24, 1912.

ROSACEÆ

Crataegus spathulatus Michx. May 6, 1912.
Crataegus Vailiae Britt. April 24, 1912.
Crataegus munda Beadle. April 21, 1912.
Crataegus Beadlei Ashe. May 6, 1912.
Duchesnea indica (Ande.) Focke. May 6, 1913.
Potentilla caroliniana Poir. April 24, 1912.
Potentilla canadensis L. April 16, 1911.
Rubus nigrobaccus Bailey. June 25, 1915.
Rubus floridus Tratt. May 6, 1912; April 16, 1911.
Rubus sp. May 6, 1912.
Agrimonia mollis (T. & G.) Britt. July 31, 1915.
Agrimonia incisa T. & G. August 20, 1913.
Rosa humilis Marsh. May 24, 1913.
Padus virginiana (L.) Reich. July 31, 1915.
Prunus umbellata Ell. July 31, 1915.
Prunus umbellata injacunda (Small) Sargent. April 24, 1912.
Prunus angustifolia Marsh. April 24, 1912.

LEGUMINOSEÆ

Morongia uncinata (Willd.) Britt. July 15, 1911.
Chamaecrista nictitans (L.) Moench. September 7, 1911.
Chamaecrista fasciculata (Michx.) Greene. August 20, 1913.
Baptisia bracteolata Ell. April 29, 1911.
Baptisia tinctoria (L.) R. Br. May 30, 1913.
Crotalaria sagittalis L. July 15, 1914.
Lupinus villosus Willd. April 19, 1914.
Trifolium procumbens L.
Trifolium pratense L. August 12, 1915.
Trifolium arvense L. July 15, 1914.
Trifolium repens L. August 12 1915.
Medicago arabica Huds. May 6, 1914.
Psoralea pedunculata (Mill.) Vail. June 2, 1913.
Robinia Elliottii (Chapm.) Ashe. May 30, 1913.
Cracca spirata (Walt.) Ktze. July 15, 1911.
Cracca virginiana L. May 30, 1913; May 16, 1914.
Wisteria frutescens (L.) Poir. April 16, 1911.
Meibomia Dillenii (Darl.) Ktze. September 20, 1911.
Meibomia nudiflora (L.) Ktze. July 15, 1913.
Lespedeza striata (Thunb.) H. & A. October 30, 1915.
Lespedeza frutescens (L.) Britt. September 7, 1911.
Stylosanthes riparia Kearney. June 25, 1915.
Stylosanthes biflora (L.) BSP. May 24, 1913.
Vicia sativa L. June 25, 1915.
Strophostyles umbellata (Muhl.) Britt. August 20, 1913.
Bradburya virginiana (L.) Ktze.
Amphicarpa monoica Ell. September 7, 1911.
Galactia regularis (L.) B. S. P. August 20, 1913; July 15, 1913.
Dolicholus simplicifolius (Walt.) Vail. May 30, 1913.
Dolicholus erectus (Walt.) Vail. July 15, 1913.

LINACEÆ

Linum medium (Plan.) Britt. July 15, 1911.
Cathartolinum striatum (Walt.) Small. July 31, 1915.

OXALIDACEÆ

Inoxalis violaceae (L.) Small. April 21, 1912; May 12, 1914.
Xanthoxalis stricta (L.) Small. April 23, 1914; April 16, 1911; April 21, 1912.

GERANIACEÆ

Geranium carolinianum L. May 6, 1912; March 9, 1914.
Geranium maculatum L. April 20, 1914.

POLYGALACEÆ

Polygala lutea L. May 30, 1913.

EUPHORBIACEÆ

Cnidoscolus stimulosus (Michx.) Engelm May 24, 1913.
Stillingia sylvatica L. May 30, 1913.
Euphorbia paniculata. April 21, 1912.
Tithymalopsis sp. May 24, 1912.

ANACARDIACEÆ

Rhus Toxicodendron L. April 21, 1912; May 20, 1913.
Rhus radicans L. April 29, 1911.
Rhus copallina L. September 7, 1911.

CYRILLACEÆ

Cyrilla racemiflora L. May 24, 1912.

AQUIFOLIACEÆ

Ilex opaca Ait. May 24, 1912.
Ilex glabra L. May 30, 1913.

CELASTRACEÆ

Euonymus americanus L. September 7, 1911; May 6, 1912; May 12, 1914.

ACERACEÆ

Acer rubrum L. April 24, 1912.

BALSAMINACEÆ

Impatiens biflora Walt. May 24, 1913.

RHAMNACEÆ

Rhamnus lanceolata Pursh. June 25, 1915.
Ceanothus americanus L. May 24, 1913; May 22, 1911.

VITACEÆ

Vitis rotundifolia Michx. May 22, 1911.

MALVACEÆ

Sida rhombifolia L. July 15, 1913.
Hibiscus moscheutos L. August 1, 1913.

HYPERICACEÆ

Hypericum fasciculatum Lam. July 15, 1913.
Hypericum mutilum L. July 31, 1915.

CISTACEÆ

Lechea villosa Ell. July 15, 1913; July 31, 1915.

VIOLACEÆ

Viola papilionaceae Pursh. April 16, 1911.
Viola cucullata Ait. April 21, 1912.
Viola emarginata LeConte. April 24, 1912.
Viola primulifolia L. May 6, 1912.
Viola palmata dilatata Ell. July 24, 1913.
Viola sp. nov. (?) April 20, 1914. Dr. E. L. Greene stated in determining the species that it is a "Near ally of *V. cucullata;* not identical with it by any means; but as a variety or as a subspecies it is nameless."

PASSIFLORACEÆ

Passiflora incarnata L. July 15, 1911.

MELASTOMACEÆ

Rhexia mariana L. June 25, 1915.
Rhexia virginica L. August 20, 1913.

ONAGRACEÆ

Ludwigia alternifolia L. September 7, 1911.
Epilobium sp. July 31, 1915.
Oenothera laciniata Hill. April 28, 1911.
Oenothera speciosa Nutt. May 6, 1912.
Kneiffia linearis Michx. May 11, 1912; May 13, 1913; May 30, 1913; May 12, 1914.
Kneiffia longipedicellata Small. May 23, 1911; June 25, 1915.

UMBELLIFERÆ

Sanicula marylandica L. July 31, 1915.
Sanicula canadensis L. May 24, 1913.
Sanicula sp. June 7, 1915.

Hydrocotyle umbellata L. June 15, 1913.
Chaerophyllum floridanum Coult. & Rose. April 15, 1915
Apiastrum patens (Nutt.) C. & R. May 24, 1913.
Ptilimnium capillaceum (Michx.) Holl. July 31, 1915; June 15, 1912.
Zizia cordata (Walt.) DC. Steedman, S. C. May 30, 1913.
Cerefolium cerefolium (L.) Britt. May 6, 1914.
Angelica villosa (Walt.) BSP. July 31, 1915.
Daucus carota L. July 15, 1911.
Daucus pusillus Michx. May 24, 1912.

CORNACEÆ

Cornus florida L. April 29, 1911; April 21, 1912; April 24, 1912.
Nyssa sylvatica Marsh. August 11, 1913; May 6, 1912; also Steedman, S. C., May 16, 1914.

ERICACEÆ

Chimaphila maculata (L.) Pursh. May 24, 1911.
Azalea viscosa L. May 30, 1913.
Azalea nudiflora L. May 22, 1911; April 15, 1912.
Kalmia latifolia L. May 16, 1914.
Pieris floribunda B. & H. July 31, 1915.
Pieris mariana (L.) B. & H.
Oxydendrum arboreum (L.) DC. June 2, 1913.
Vaccinium atrococcum (Gray) Heller. April 24, 1912.
Vaccinium caesium Greene. April 16, 1911.

PRIMULACEÆ

Samolus floribundus H. B. K. May 11, 1912; June 20, 1914.

STYRACACEÆ

Styrax americana Lam. May 6, 1912.

OLEACEÆ

Chionanthus virginica L. July 31, 1915

LOGANIACEÆ

Cynoctonum sessilifolium (Walt.) J. F. Gmel. August 1, 1913.
Polypremum procumbens L. August 1, 1913; June 25, 1915.

APOCYNACEÆ

Apocynum cannabinum L.

ASCLEPIADACEÆ

Asclepias variegata L. May 22, 1911; May 13, 1913.
Asclepias tuberosa L. May 24, 1913; May 30, 1913.

CONVOLVULACEÆ

Quamoclit coccinea (L.) Moench. August 20, 1913.
Ipomoea purpurea (L.) Roth. November 1, 1915.
Ipomcea pandurata L. July 15, 1911.
Cuscuta arvensis Beyr. August 1, 1913.

POLEMONIACEÆ

Pholox amoena Sims. May 30, 1913.
Phlox maculata candida Michx. July 15, 1911.
Phlox maculata L. May 30, 1913.

BORAGINACEÆ

Lithospermum Gmelinii (Michx.) A. S. Hitch. May 30, 1913; also Steedman, S. C. May 16, 1914.
Onosmodium virginianum (L.) DC. May 16, 1914.

VERBENACEÆ

Verbena urticaefolia L. June 17, 1913.
Callicarpa americana L. August 1, 1913.

LABIATEÆ

Scutellaria pilosa Michx. May 30, 1913.
Scutellaria integrifolia L. May 14, 1913; May 16, 1914; June 25, 1915.
Scutellaria montana Chapm. May 7, 1915.
Prunella vulgaris L. May 22, 1911; May 11, 1912.
Stachys arvensis L. June 25, 1915.
Salvia lyrata L. April 21, 1912; May 24, 1913; April 29, 1911; June 25, 1915; May 16, 1914.
Salvia azurea Lam. October 10, 1914.
Kcellia flexuosa (Walt.) Mac M. June 25, 1915.
Koellia hyssopifolia Michx. June 25, 1915.
Mentha spicata L. September 30, 1914.
Mesosphaerum rugosum (L.) Pollard. August 1, 1913.

SOLANACEÆ

Solanum carolinense L. May 24, 1912.
Solanum nigrum L. July 31, 1915.
Datura stramonium L. August 12, 1915.

SCROPHULARIACEÆ

Verbascum Thapsus L. July 31, 1915.
Linaria canadensis (L.) Dumort. April 20, 1914; April 18, 1911.
Pentstemon hirsutus (L.) Wild. May 16, 1914.
Pentstemon canescens Britt. May 6, 1912.
Pentstemon sp. May 24, 1913.
Mimulus alatus Soland. August 20, 1913.
Digitalis purpurea L. June 28, 1914.
Gratiola aurea Muhl. June 15, 1913.
Dasystoma flava L. July 31, 1915.
Dasystoma pectinata Nutt. July 16, 1915.

LENTIBULARIACEÆ

Utricularia purpurea Walt. May 30, 1913.
Utricularia vulgaris L. May 16, 1914.

BIGNONIACEÆ

Tecoma radicans (L.) Juss. July 15, 1911; July 31, 1915.

ACANTHACEÆ

Ruellia hybrida Pursh. July 15, 1914.

PLANTAGINACEÆ

Plantago heterophylla Nutt. April 15, 1914.
Plantago virginica L. May 6, 1912; April 15, 1914.
Plantago aristata Michx. July 15, 1911.
Plantago lanceolata L. August 12, 1915.

RUBIACEÆ

Galium hispidulum Michx. June 25, 1915.
Galium Claytonii Michx. June 15, 1912.
Galium tinctorium filifolium Wiegand. June 20, 1914.
Galium pilosum Ait. August 20, 1913.
Galium triflorum Michx. May 11, 1912.
Diodia teres Walt. October 30, 1915; August 1, 1913.
Mitchella repens L. September 20, 1911; May 11, 1912; August 20, 1913.
Cephalanthus occidentalis L. May 24, 1912.
Houstonia ciliolata Torr. April 18, 1911.
Houstonia serpyllifolia Michx. April 21, 1912.
Houstonia coerulea L. April 15, 1914.

CAPRIFOLIACEÆ

Lonicera japonica Thunb. June 25, 1915.
Lonicera sempervirens L. April 29, 1911; April 24, 1912.
Symphoricarpos orbiculatus Moench. June 25, 1915.
Linnaea borealis L. May 11, 1912.
Viburnum rufidulum Raf. April 29, 1911.
Viburnum prunifolium L. July 15, 1913.
Sambucus canadensis L. July 15, 1911; May 24, 1912.

CAMPANULACEÆ

Specularia perfoliata (L.) A. DC. April 18, 1911; May 6, 1912.

LOBELIACEÆ

Lobelia syphilitica L. September 20, 1911; August 20, 1913.
Lobelia cardinalis L. September 7, 1911; July 15, 1913; August 20, 1913.

COMPOSITEÆ

Vernonia noveboracensis (L.) Willd. August 1, 1913.
Vernonia angustifolia Michx. July 15, 1913.
Elephantopus tomentosus L. September 7, 1911; August 20, 1913.
Eupatorium aromaticum L. September 20, 1911; October 10, 1914.
Eupatorium hyssopifolium L. September 7, 1911; August 20, 1913.
Eupatorium purpureum L. July 31, 1915.
Eupatorium capillifolium (Lam.) Small. October 10, 1914.
Mikania scandens (L.) Willd. August 1, 1913.
Chrysopsis graminifolia (Michx.) Nutt. September 7, 1911; March 13, 1914; July 31, 1915.
Chrysopsis mariana L. September 20, 1911.
Solidago odora Ait. Fall of 1913.
Solidago petiolaris Ait. October 10, 1914.
Solidago brachyphylla Chapm. October 10, 1914.
Euthamia tenuifolia Nutt. July 31, 1915.
Aster infirmus Michx. August 20, 1913.
Aster linariifolius L. October 10, 1914.
Aster concolor L. October 10, 1914.
Aster patens Ait. October 10, 1914.
Aster lateriflorus (L.) Britt. October 10, 1914.
Isopappus divaricatus (Nutt.) T. & G. August 20, 1913.
Erigeron canadensis L. August 1, 1913.
Erigeron ramosus (Walt.) BSP. May 22, 1911; August 1, 1913; May 12, 1914.
Erigeron quercifolius Lam. April 16, 1911.
Sericocarpus linifolius (L.) BSP. July 15, 1913.
Sericocarpus asteroides (L.) BSP. July 15, 1913.

Baccharis halimifolia L. November 10, 1913.
Gnaphalium purpureum L. July 15, 1913.
Gnaphalium spathulatum Lam. April 21, 1914.
Gnaphalium sp. July 15, 1911.
Silphium asteriscus L. September 7, 1911; May 24, 1913; July 15, 1913.
Silphium compositum Michx. July 15, 1913.
Chrysogonum virginianum L. April 18, 1911; April 24, 1912.
Ambrosia artemisifolia L. September 30, 1914.
Xanthium canadense Mill. September 30, 1914.
Eclipta alba (L.) Hassk. October 10, 1914.
Rudbeckia laciniata L. May 22, 1911; September 20, 1911.
Rudbeckia amplectens T. V. Moore. July 31, 1915.
Helianthus astericus. June 25, 1915.
Helianthus anuus L. June 10, 1915.
Helianthus atrorubens L. September 20, 1911.
Coreopsis major Walt. May 22, 1911.
Coreopsis lanceolata villosa Michx. April 18, 1911.
Coreopsis delphinifolia Lam. June 25, 1915.
Marshallia obovata (Walt.) B. & B. June 20, 1914.
Helenium tenuifolium Nutt. July 15, 1911.
Achillea millefolium L. August 12, 1915.
Anthemis cotula L.
Chrysanthemum leucanthemum L. August 14, 1915.
Senecio balsamitae Muhl. April 18, 1911.
Carduus spinosissimus Elliottii (T. & G.) Parker. May 24, 1913.
Carduus Lecontei (T. & G.) Pollard. June 25, 1915.
Cirsium discolor (Muhl.) Spreng. June 15, 1912.
Krigia virginica (L.) Willd. May 6, 1912.
Sonchus asper (L.) Hill. May 6, 1914.
Hieracium venosum L. April 21, 1912.
Willughbya scandens (L.) Ktze. September 7, 1911.
Facelis apiculata Cass. June 30, 1914.

UNITED STATES DEPARTMENT OF AGRICULTURE,
EL CENTRO, CAL.